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ABSTRACT

To determine whether argument is logical, this paper reviews the empirical literature on perception, memory, and reasoning. It finds cognitive processes to be inferential, thus supporting the assumption that argument is logical. It notes, however, that a cognitive view of argument must be taken to appreciate this logicality, because people commonly use premises not available in a rhetorical or experimental text to solve problems. The paper concludes that when these emendations are not noticed, many responses are taken for logical errors. (Author/FL)

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A REVIEW OF EMPIRICAL LITERATURE ON LOGICAL PROCESSES

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Abstract

The goal of this paper is to settle the question, Is Argument logical? To that end, empirical literature on perception, memory and reasoning is reviewed. Cognitive processes are found to be inferential, and so to support the assumption that argument is logical. However, a cognitive view of argument must be taken to appreciate this logicality, because people commonly use premises not available in a rhetorical or experimental text in order to solve problems. When these emendations are not noticed, many responses will be mistaken for logical errors.

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A REVIEW OF EMPIRICAL LITERATURE ON LOGICAL PROCESSES

Even on the unlikely assumption that only coincidence made one man the father of both logic and rhetoric, no one could deny that the association between the two disciplines has been close for thousands of years. Logic has always been our basic model for invention: we have, after all, given rhetorical induction and deduction prominent places in nearly all our full-fledged theories of rhetoric. But just as rhetoricians could be banned from world capitals from time to time, so could the relation between logic and rhetoric be questioned.

Mountains of empirical results offering evidence that people don't always reason logically constitute a serious contemporary challenge to the wisdom of using logic as a model of argument. In spite of the traditions which use logic or mathematics as a foundation for rhetorical (Broadrick, 1950) and psychological (Peterson & Beach, 1967) theories, if empirical evidence points clearly to widespread logical incompetence, we should abandon that model of argument. And in fact, the research results are not reassuring. Though Erickson (1978) found a comforting 94% accuracy rate for solutions to figure I syllogisms, his review of five major studies shows only 20-30% accuracy for figure II, III and IV problems. DeSoto, London and Handel (1965) found that people were correct no more than 40-60% of the time, even when the conclusions were provided by the experimenters, and subjects had only to say if the conclusion were right, wrong or indeterminate. Errors are so frequent that psychologists have spent the last half century trying to develop a coherent theory to capsulize the great varieties of invalidities we attempt: we perform poorly on problems which include negatives; we don't use logical connectives properly; we will accept nearly any conclusion which has the same atmosphere (particular or negative) as the premises; we reserve implications; we allow ourselves to be influenced by what we'd like to see true; sometimes we mishandle concrete terms, and sometimes we do better with contentless letters. And besides all that, we commit fallacies. (For reviews of literature, see Miller, 1969; Wason & Johnson-Laird, 1972; Johnson-Laird & Wason, 1977, pp. 75-88; Bourne, Dominowski & Loftus, 1979, ch. 9.) As the editor of a major collection of work generally sympathetic to the logical model remarks, " . . . adult reasoning in propositional situations is notoriously only in loose correspondence with what the ideal logical model would prescribe . . . " (Falmagne, 1975, p. 2).

But loose correspondence may be good enough. No model of human behavior will ever be perfect. And even models which in their simpler forms explain only moderate amounts of variance in human responses are perfectly acceptable, so long as elaborations can explain the remaining systematic behavior. To mount a successful defense of logic, then, it is not necessary to deny that people make many logical errors: the task is to explain them. Since logic's explanatory hypotheses will not be found in the domain of logic. Instead, we ought to look to cognitive psychology for proposals which will cover logical aberrations.

In particular, we need to examine perception and memory in hopes of better describing logical processes. So long as we regard argument as a mental rather than documentary phenomenon (see Hample, 1978), a cognitive perspective is appropriate.

Focusing on the individual, then, imagine how an enthymeme (Bitzer, 1959; Delia, 1970) is processed. First it must be heard or seen. The enthymeme itself does not enter the cognitive system; only its percept does. The trace remains in the person's sensory registers for between 1/4 and 2 seconds, then is read into short-term storage, where it stays for as long as half a minute without rehearsal or processing of any kind (Craik & Lockhart, 1972). If the data are not processed in some way, the trace will disappear and the enthymeme, of course, will have failed. But the nature of an enthymeme is to be joined with the individual's belief system, and if it is processed in that way, it will move into long-term storage. If the person is required to make some kind of response to the enthymeme at a later time (say on a memory task of some kind), the information will have to be retrieved from long-term memory (LTM).

Assuming that a logical error of some sort were made on the memory task, we could reasonably suspect that several things might have happened: a) the stimulus enthymeme may not correspond to the trace in sensory registers; b) it may have been altered in short-term memory (STM); c) it may have changed during the processing which moved it into LTM; d) distortion may have occurred during storage in LTM; e) it may have been altered during retrieval; or f) it may be inaccurately represented during the response production for the test. Of these, f) is uninteresting (perhaps test fatigue or a slip of the pencil) and I am unaware of any evidence bearing on d). Each of the other perceptual or memorial events is a likely explanation for at least some logical errors. And interestingly, most of the errors will turn out themselves to be possibly the results of logical process--processes, of course, contradicting those proposed by the enthymeme. To explain those processes, and so to elaborate on the logical model of cognitive argument, this paper will review pertinent literature on perception, then memory, and finally reasoning.

Perception

The study of perception explores our contact with the external world. Only through perception does anything become eligible for information processing at all. Although the following review is hardly a complete summary of what we know about perception, it will nonetheless expose or eventually elucidate logical processes.

The first findings of which we should be aware are those which indicate that perceptual style is an important determinant of memory. On one hand, this is an obvious statement: nothing can be encoded for storage that did not enter the cognitive system. But the relationship between perception and memory is more subtle than that, as the depth of processing research shows. Memory is a nearly automatic consequence of perceptual processing (Craik & Lockhart, 1972; Craik & Tulving, 1975). "Depth of processing" refers to levels of perceptual analysis: these levels may vary all the way from sensory recognition of lines and bright patches to pattern matching to extract meaning from a stimulus. The deeper the processing, the better the memory. Craik and Tulving (1975) showed subjects various words, and required them to respond to questions about the word's typescript (capital letters?), whether it rhymed with another word, or whether it belonged to a given category (animal?). This task forces people to process the words morphologically, phonetically or semantically. At the end of the task, the experiments gave a memory test; words processed semantically were remembered best, as the

theory predicts (semantic processing is held to be deepest of the three). Since this was an incidental learning task, it provides strong support for the theory. Roenker, Wenger, Thompson and Watkins (1978) performed a similar study in which semantically processed words were better recalled than those where subjects answered questions about rhyme or spelling. Epstein, Phillips and Johnson (1975) also replicate the basic result, even finding that recall for semantically processed words was superior to recall for words subjects were told to remember.

These last two studies included experimental conditions which suggest a slight elaboration of the theory. In Epstein, Phillips and Johnson (1975), people had to find similarities or differences between two related or unrelated words. Recall was best for the harder tasks: finding differences between similar words or similarities between unrelated words. This finding suggests that some types of semantic processing are deeper than others. Roenker, et al (1978) either gave words to subjects, or had people generate their own words. The specific semantic task was to answer category questions (Is a tree?). The experimenter-provided words were best recalled when they were category members (replicating several previous studies), but the subject-generated words were remembered better when they weren't category members. The explanation for this contrast is that nonmember words were harder for people to generate, and so required more processing (making them more memorable). Johnson-Laird, Gibbs and de Mowbray (1978) also report relevant data. Their subjects had to decide whether words belonged to a category which was specified by three characteristics; the words had from zero to three of the characteristics. The authors' extremely clear results show that recall is more likely for words having all three characteristics, next best for two, and so forth, down to worst recall when nothing is shared with the category description. In other words, the more qualities which had to be considered to make the decision, the better the recall. This study is important, for it allows quantification of the idea of "depth," and shows lucidly that memorability is determined by amount (depth) of processing. As Craik and Tulving (1975) summarize, " . . . items are remembered not as presented stimuli acting on the organism, but as components of mental activity. Subjects remember not what was 'out there' but what they did during encoding" (p. 292).

Although these results make clear that perception influences memory, the opposite is true as well. Material stored in LTM has much to say about what is perceived in the first place. For our purposes, we need to examine two sources of influence: schemata and category systems.

For Bartlett (1932), schemata were "active organized settings" (p. 212) which new information both fit and altered. A number of theories use similar notions to explain how one's preconceptions affect what is available for perception or memory (see Neisser, 1976, ch. 4). Minsky's (1977) theory of frames (which is quite different from Goffman's) is one of these. He says that a frame will be taken from memory to fit any new problem or situation. For example, before entering a room for the first time, one will have a frame which includes walls, floors, ceiling, number of corners, and so forth. Each frame has both constant and variable elements (e.g., number of walls). The variables have default values, which correspond to expectations. Frames are matched to situations; if the match fails, a different frame may be selected (e.g., "hall of mirrors"). One implication of their theory is that a sentence must be understood within a frame; and further, that every

perception of a sentence will be perceived from the vantage point of one frame or another. When we later come to consider whether real world sentences can be processed purely or whether every sentence sets off a chain of natural inferences, this implication of Minsky's theory will help settle the question.

Minsky's field of interest is artificial intelligence, and his choice of terms belies that perspective. A script is "a coherent sequence of events expected by the individual, involving him either as a participant or as an observer" (Abelson, 1976, p. 33). For example, one might have a restaurant script, which includes menu, waitress, how to be seated, whether to tip, etc. Scripts may be episodic or semantic, and are composed of a series of vignettes (images or conceptual representations of an event). Scripts allow perceptual inferences. For instance, suppose you are in a coffee shop and have therefore invoked your restaurant script. A happy sound directs your attention to a corner table, where you see an unknown woman wearing an apron and short skirt standing next to the table, where another unknown woman sits before several plates of untouched steaming food. You would very likely perceive that "a waitress has served a meal," though of course you had observed nothing of the kind. The script forces the inference. In fact, I find myself thinking of scripts, frames and schemata as organizations of warrants which automatically transform data to conclusion. Schank and Abelson (1975) have even written a computer program, SAM (Script Applier Mechanism), which makes inferences about a situation based on what script is in force.

Several studies illustrate the usefulness of the idea of schemata. Cohen and Ebbeson (1979) manipulated perceptual schemata by telling half their subjects they were learn a task by watching a person on videotape, and telling the other half that they were to form an impression of the person. In accord with expectations, subjects using a task schema had much more accurate memory for actions performed on the videotape than did people with an impression-forming schema in force. Frase (1978) was able to improve 10-year-olds' inferential ability in a similar way. He told some of the children to attend to middle terms (e.g., he told them to watch for "the red thing" when they were to read "The small thing is red" "The red thing is a bag"). Children so instructed identified the inference as true 94% of the time, while children who were not cued only recognized the inference 64% of the time. Abelson (1976) uses scripts to explain many nonrational decisions. He says that many people use episodic scripts ("The applicant reminds me of myself at that age, and I worked out"), but won't admit it, claiming to be using more socially desireable abstract scripts ("After a careful study of her GPA, GREs, ..."). He suspects this explains the apparent irrationalities reported by Slovic, Fischhoff and Lichtenstein (1976), Nisbett, Borgida, Crandall and Reed (1976), and Carroll and Payne (1976) in the same volume.

A schema's flexibility is quite important. We have already noted Bartlett's view that the incoming information modifies the schema, and of course Minsky's theory makes explicit room for variables. Schemata, then, are not permanent or immutable, Neither are they in perfect control of the perceptual process: some room must be left for the influence of the stimuli themselves, and somehow the selection of schemata needs to be explained. In the area of pattern recognition, where the schema is a pattern held in LTM, Norman (1976, ch. 3) explains that perception is <u>both</u> data-driven (influenced by the stimuli) and concept-driven (influenced by expectations), A study by Oden (1979) nicely shows the need for flexible schemata. He showed subjects "letters" in which two features systematically shaded the letters into one another from trial to trial--for example, the upper left bar on "T"

and the middle horizontal line of "F" would change so that the letters evolved into one another. Subjects were required to identify the letter. Results supported Oden's notion that we have "fuzzy" models: people can deal with degrees of fit, can use a model when its prototype does not work perfectly, and can use alternative patterns when need be.

One particular type of schema deserves emphasis here, though most of the discussion will be deferred to the section on memory. Categories are used in LTM to store material in clusters; this appears to be the dominant form of semantic memory, as we will see. Categories affect perception, of course. Humphreys (1978) asked subjects to identify a projected image as being either a letter or number after it had been briefly (in fact subliminally) preceded by another letter or numeral. He found a marked deterioration in category discrimination when the subliminal primer belonged to the other category. The "category-priming effect" shows how even in a fairly unambiguous perception task, a schema (cued by the primer) has a very strong effect on how stimuli are perceived.

Results like Humphreys', however, can be over-interpreted. To imagine that schemata cannot be changed would imply that they often systematically mislead, and so betray their purpose. But as Bartlett (1932) insisted, "...all the cognitive processes which have been considered, from perceiving to thinking, are ways in which some fundamental 'effort after meaning' seeks expression" (p. 227). Schemata focus, and therefore filter, but they do so in the interests of greater overall efficiency, since our cognitive capacities for information processing are limited (Broadbent, 1965; Turvey, 1974; Dawes, 1976; Shaklee, 1979). "The perceiver in any social action will act in such a way as to reduce the need for information to sustain the interaction process, This...implies a general tendency to adopt simplifying strategies in our interactions with others, strategies which are in the service of cognitive and emotional economy" (Jones & Thibaut, 1958, p. 152). Nonetheless, efficiency has its own price, and we will have much to say about schemata later in the paper.

The groundwork has now been laid for making the last, but most important point about perception: that it is inferential, or constructive. Turvey (1974) defines constructive theory in such a way as to highlight its inferential nature:

> Constructive theory assumes that perceptual experience is not a direct response to stimulation. Rather, perceptual experience is constructed or created out of a number of ingredients, only some of which are provided by sensory stimulation. Other ingredients in a perception recipe are provided by our expectations, our biases, and our knowledge of the world in general. (p. 165)

It is unhappily true, for instance, that people ordinarily "fill in" the implications of advertising, because they understood what the advertisers really intended to say (Preston, 1967; Preston & Scharbach, 1971).

Bransford and McCarrell (1975) explain that one must know the relations between objects (i.e., have a schema) in order to understand an object's meaning. Thus, people must make cognitive contributions to a perception in order to comprehend it. They cite examples (we will review this literature ourselves in the next section) wherein subjects heard sentences, but remembered inferences which were based on the sentences and information from LTM. They insist that ". . . one can have knowledge of language and yet fail to understand utterances if one is unable to activate appropriate knowledge of the

world" (p. 208). In this connection, Johnson-Laird and Wason (1977) have noticed that recognition of the illocutionary force of a sentence is always an inference. "Can you tell me the time?" for example, is clearly a request rather than a question, but the evidence for my certainty on this point obviously cannot come from the sentence alone. Schweller, Brewer and Dahl (1976) report, in fact, that people will think (falsely) that they heard sentences with the same illocutionary force as the ones actually presented to them.

Some research indicates that these inferences are made at the time of perception or storage in STM. Masson's (1979) subjects learned sentences with or without an associated cue word. The inference cues (if Word, then Sentence) seemed to work only when the inferences were made during the initial encoding. Dawes (1966) found that distortion of sentences did not increase over time, and concluded therefore that it occurs immediately upon perception of the sentence, or not at all.

Perhaps more familiar research will show the process more clearly. Implicit Personality Theory (IPT) refers to the associations (or conditional probabilities) stored in LTM regarding personality traits (see Hays, 1958; Rosenberg & Sedlak, 1972; Cohen & Ebbeson, 1979). So, for example, one might have a theory that cheerful people are warm. IPT can be viewed as a collection of such inferences. Workers in the area of Kelly's Personal Construct Theory, in fact, have an instrument (the Impgrid) which requires respondents to indicate their inferential patterns (Hinkle, 1965; see Fransella & Bannister, 1977). Once a subject has provided (or been given) a list of personality traits, the interviewer begins: "If a person changes on this trait (T_1), will he change on this one (T_2)? This one (T_3)?" and so forth. Kelsall and Strongman (1978) have successfully used the Impgrid to measure consistency among subjects' emotional constructs; however, the usual procedure is to assess personality traits.

An early study of IPT by Bruner, Shapiro and Taguiri (1958) clearly shows the inferential nature of our trait schemata. Their subjects first estimated the conditional probabilities of various trait relations (e.g., "If someone has T_1, how likely is to that he has T_2?"). Target people were then described in terms of three of those traits, and subjects assessed the likelihood that the target had other traits as well. The authors found that when all three words had a strong link to another trait, the target was thought to possess it; when two of the three traits were linked to another, the target was perceived to have it 79% of the time. The authors were led to conclude that the meaning of a trait is nothing but ". . . the set of inferences that can be made, with varying degrees of certainty, from it to other traits" (p. 286). Awareness of these "linguistically conditioned inferences" (Bruner, et al, 1958, p. 278) leads Jones and Thibaut (1958) to argue that "perception" may actually be a misleading word, and that we should think of inference, induction and deduction in connection with what has been labeled person perception. IPT, then, is a set of trait warrants (if T_1, then T_2), along with the behaviors which indicate the presence of each trait (Cohen & Ebbeson, 1979). Cook (1971) says that we use identification rules to collect initial trait information from people's behavior, and then apply association rules to those traits in order to generate additional information about the target person.

Attribution theory (see Jones & Davis, 1965; Jones, Kanouse, Kelley, Nisbett, Valins & Weiner, 1972; Shaver, 1975; Jones, 1976) deals with our explanations of others' behavior: whether someone acts harmfully because

he is full of malice or because he has no alternative, for example. The simple fact that we make attributions is evidence that ". . . behavior is always an interpretation on the part of the observer, a set of inferences that partly ignore and partly go beyond whatever 'act' has been performed" (Carrol & Payne, 1976, p. 16). The classic theory is that in making attributions, we consider certain types of evidence from LTM for our conclusions: whether others always perform the behavior, whether the target consistently performs the behavior, and whether the behavior is distinctive to the situation (see Nisbett, et al, 1976). Fontaine (1975) suggests that the theory works only in relatively artificial situations; he found that in real circumstances, people use ego-oriented information for their attributions, and neglect the rationally-pertinent data. But Eisen (1979) reports suggestively that when actors and observers had access to the same information (accomplished by giving the observers self-generated data from the actors), the usual differences in actor and observer attributions disappeared (ordinarily actors emphasize environmental explanations for their own negatively-valenced acts, while observers explain the acts by reference to the actor's internal dispositions). This suggests that differences in available data must be considered in evaluating any detected attributional differences. We have long known, for example, that ego-defense and wishful thinking may affect attribution (Heider, 1958); these factors obviously involve additional premises. Nisbett, et al (1976) found that consensus information is not always used in attribution; this result may simply reflect the use of different warrants or different weights for data. In short, attribution is clearly an inferential event, and even the departures from theory may only point to more complex inferences than the theories ordinarily consider.

This review of some literature on perception--person or otherwise--shows that our information processing is already under way long before we begin consciously thinking about something.

> All the work on perceptual and pattern recognition processes emphasizes the interpretative, constructive nature of perception, and because the information about the world that gets into a person's memory must have first passed through the perceptual system, the information must also reflect this interpretive, constructive nature. (Norman, 1976, p. 167)

Our constructions of the world invoke schemata, which focus, filter and adapt; these cause us to make inferences in our "effort after meaning." All this affects what finds its way into LTM, for both the nature of the processing and its results have been shown to be important determinants of what is stored, and how accurately. It is time now to consider memory, where we will find additional evidence for the pervasiveness of inference in cognition.

Memory

As we have already noticed, schemata stored in LTM may be viewed as collections of connected warrants. These "active structural networks" (Norman, Rumelhart & the LNR group, 1975) contain assumptions, implications and explanations of material actually contained in the deep structure of a given sentence. Thus, sentences "...can have semantic implications that extend beyond the information they directly express" due to their integration into existing schemata (Bransford, Barclay & Franks, 1972).

The previous section reported evidence that such implications may occur during perception. They may occur afterwards as well. Keenan and Kintsch (1974) exposed subjects to paragraphs which did or did not require an inference

to be comprehensible. After reading the material, subjects indicated whether the implied statement were true or not, based on the paragraph. Reaction time (RT) was much faster when the "implied" statement was explicit (rather than only implicit), on the immediate posttest. But when RT was measured 20 minutes after exposure to the paragraph, the RT difference between the explicit and implicit conditions disappeared. This suggests that the inference was made in memory, but not necessarily at the time of perception; certainly, it is clear that the inference was stored in LTM along with the rest of the paragraph. Norman (1976) provides a possible explanation: rehearsal. Rehearsal can keep an idea in STM by restimulating it. The rehearsal can be for maintenance (repeating a sentence) or elaborative (exploring associations between the new information and that stored in LTM). Bjork (1975; Bjork & Jongewald, 1975, cited in Norman, 1976) indicates that elaborative rehearsal is far more effective in preserving the trace in LTM. Thus, rehearsal of information may cause inferences to be made and stored well after the perception process has finished.

A number of studies show that people's memories do not distinguish between material actually presented to them, and inferences drawn from it. Kevin (1971, cited in Barclay, 1973) read subjects complete and conclusion-less syllogisms, and later asked people to certify sentences as having been presented or not. The enthymemes were often spontaneously filled in. "False recognition was more frequent for valid conclusions than for invalid ones, reflecting a tendency for Ss to complete the partial syllogisms and then store the completed constructions" (Barclay, 1973, p. 233).

Franks and Bransford (1972) found a similar tendency for people's memories to fill out "good figures" (see De Soto & Albrecht, 1968). They generated complex sentences which involved four ideas (e.g., "The fox ran [1] through the woods [2], past the hollow [3] where the dogs waited [4]"). Subjects were given sentences which contained one, two, three or four of the ideas. Their task was then to recognize the sentences given them, and to rate their confidence in the recognition. Subjects were more confident they had seen the sentence (whether they had or not) when the test item had all four bits of information, next best when it had three, and so forth. Franks and Bransford therefore argue that subjects attempt to integrate all the partial meanings and to store the completed idea; it is the match between the test sentence and the entire schema which controls their responses.

Bransford, Barclay and Franks (1972) provide additional evidence for the interplay of schema, stimulus, memory and inference. They gave subjects sentences like "three turtles rested on (or "next to") a floating log, and a fish swam beneath them." Half the subjects (for whom the turtles were on the log) would know, based on information in LTM, that the fish would therefore have also swum under the log; this would not be true for the subjects who were told that the turtles were next to the log. Far more people who were told the turtles were on the log wrongly thought they had been told the fish swam under it. In general, subjects seemed unable to distinguish between inferences and the sentences which stimulated them; even in other studies where people were generally accurate in identifying the original sentences, the inference was the most common error. The authors properly emphasize that these inferences must have been based upon, and stored in, LTM; they could not have been deduced in any way from the sentences' deep structures.

Milkovitch and Housel (1977) illustrate the role that such inferences may play in improving memory. Their subjects read lists of related sentences which had theme sentences of varying explicitness; when high-explicit sentences were present, memory for the whole list improved. Thus, the more developed the inferential structure, the better will be retrieval from LTM.

Not only can this result be observed when sentences interact with LTM or with other sentences, as indicated above, but the effect can also occur within a sentence. Clark (1975; Haviland & Clark, 1975) makes a given/new distinction for information conveyed in a sentence. "It was the tall man who took the basket" seems to presuppose that the listener knows a basket was taken (i.e., that much is given), and offers the new data that the tall man took it. Clark observes that upon hearing such a sentence, people will store "the basket was taken," whether they previously knew it or not, Sometimes the presupposition will not be quite so obvious; yet it may still be detected and stored. Thus, upon hearing "I met two doctors yesterday; the woman told me a story," a subject will often realize and remember that one and only one of the doctors was a woman. Haviland and Clark suggest that the given information is used as an address in LTM, helping to form a context for the storage and comprehension of the new data.

All these results are reinforced by the finding that people store the gist of a sentence, not the verbatim statement, in memory (Fillenbaum, 1966). Harris (1979), in fact, found no difference in cued recall for sentences containing metaphors, dead metaphors or none, and so concluded that people can recall the metaphorical meaning, even though the metaphor itself is not stored in LTM. Several researchers (Brewer, 1977; Harris & Monaco, 1978) find that people make what are called pragmatic inferences and store those. Upon hearing "The hungry python caught the mouse," for instance, most people will recall that the python ate the mouse. That memory is pragmatic and stores ideas, not sentences, helps explain the results of Smith, Adams and Schorr (1978). One theory of forgetting is that new information interferes with the recall of old; given such a theory, these researchers wondered how memories can ever accomodate more material. Their subjects learned lists of integrated or unintegrated sentences. Interference increased when an extra unintegrated sentence was added to the list, but not when the extra sentence integrated the others. Subjects who read the integrating sentence also had more trouble identifying new related sentences as not having been in the original list.

Nor is the general argument affected by the use of images in processing or recall (e.g., Barclay, 1973). Norman, Rumelhart and the LNR group (1975) maintain that images are stored as though they were propositions. This explains how an image can have a propositional kind of error in it (in recall of a party, the wrong person is pouring the scotch), but not usually a non-propositional one (half the room is gone from memory, like a ripped photograph) (see Pylyshyn, 1973).

So far, we have looked solely at semantic or pragmatic schemata to explain the existence of inferences in the cognitive system. Evidence on spatial schemata also bear on this point. First of all, it seems fairly clear that we do in fact have such structures. Shepard and Chipman (1970) found that the way people think about the shapes of states (e.g., Texas) corresponds closely to the states' actual shapes. De Soto, London and Handel (1965) found that people are much more comfortable (and accurate) with linear syllogisms that move from left to right ("A is to the left of B") than from right to left, and that relations like "better-worse" are converted into a

vertical scale: ". . . the inner procedure in thinking about orderings consists primarily in arranging elements on an axis in some cognitive space" (p. 250).

Potts' (1972; 1978) discovery of the "distance effect" has guided exploration of such cognitive space. He asked people to learn linear syllogisms (A>B>C>D) with or without being told about the immediately adjacent relationships. On testing subjects, he found that memory was best for nonadjacent pairs (A>C?) whether they had been presented explicitly or not. RT was slower for adjacent pairs than for distant ones. These results show that the inference (is A>C?) does not occur at the time of the test: if that were the case, subjects would have to work through the problem (A>B, B>C, so. . .), and longer sequences would require more RT. Consequently, Potts concludes that subjects infer the whole order, and store that in LTM, rather than the premises. Moyer (1973) and King, Gruenewald and Lockhead (1978) support this theory by reporting that RT required to sort items is inversely proportional to the relative size differences among the items; Ashcraft and Battaglia (1978) found that wrong answers to addition problems were detected more rapidly when they were further from the correct answer.

Several investigators have tried to discover whether the cognitive axis is an interval or ordinal scale. Moyer and Bayer (1976) indicate that actual, not merely relative, sizes may be stored. They taught subjects to associate nonsense syllables with circles of various sizes, and then asked people to say which of two syllables was associated with the larger circle. The greater the relative difference, the quicker the RT, of course. But the researchers also report that the largest set of circles was processed more rapidly, suggesting that more than a simple ordering was stored. But other work shows that our ability to store detailed information on sizes is limited. Mayer (1978) gave precise information regarding the A, B, C and D orderings. He told people, for example, that A=2*B, B=3+C, etc., either in stories or equations. He discovered, as we would expect by now, that inference accuracy for comparative questions (is A greater than C?) increased with the size of the inference leap. But he also found that numerical answers (is A equal to 2*D+4?) became less accurate with increasing numbers of steps. On the whole, it seems safe to conclude that we store orders spatially, but probably do not bother to infer exact locations on an interval scale.

Memory for ordinal inferences seems to be active, filling out missing inferences, while exact numerical information will probably be filtered out of our ordinal spatial schemata. One would therefore expect that people would do better on linear syllogisms than on families of equations, as was the case in Mayer (1978). A more general implication of this spatial work is that questions which fit our schemata will be more accurately answered. De Soto, London and Handel (1965) report that our horizontal cognitive axis is ordered from left to right (probably because of Western reading practices); Miller (1969) indicates that people can be confused by "B is to the right of C; A is to the right of B; is C to the left of A?" which badly violates our spatial schemata. Similar results should occur for violations of semantic or pragmatic schemata as well.

Although it is not quite time to consider the reasoning literature, we can anticipate some of it by comparing memorial processes to the enthymeme. Delia (1970) has already argued forcibly that the enthymeme can be understood as "the employment of the deductive form in accordance with the operation of the natural rational process of consistency maintenance" (p. 147). In other words, enthymemes will be effective to the extent that they press conclusions

which fit consistent patterns. Such schemata seem to have a memorial advantage over inconsistent ones, under most circumstances. Several studies (Zajonc & Burnstein, 1965; De Soto, Henle & London, 1968; Picek, Sherman & Shiffrin, 1975) show that balanced systems of people (or people and issues) are better remembered than imbalanced ones. Miller (1979) found that when subjects make errors describing imbalanced situations, about two-thirds of the errors involve describing imbalanced systems as balanced. In a widely-cited paper, Schulman (1974) required subjects to indicate whether or not nouns were properly (congruously) categorized, and whether attributions of adjectives were congruous or not. He, too, found that memory was better for congruous relations. Hastie and Kumar (1979), however, reported a memorial advantage for behaviors incongruent with a list of traits for a fictional person. The traits were all synonyms, though, and this suggests that the behavioral information had to be integrated to fill out a very redundant image of the target person. The depth of processing research supports the claim that more processing leads to better memory, and the incongruent data were probably processed more thoroughly in this study than the congruent information. In sum, LTM seems to prefer consistent schemata, and information will ordinarily be best recalled if it fits into an appropriate frame. This, of course, suggests a family relationship between LTM and the enthymeme.

Another suggestion to the same end comes from recognition of the categorical structure of LTM. The classic logic, of course, is categorical--subjects are associated with predicates--and most memory theories describe LTM the same way. LTM is not organized randomly: people impose order on material, and do better as they grow older and develop cognitively (Wyatt & Geis, 1978). Several studies (Bousfield, 1953; Buschke, 1977) show that LTM contains clusters of associated words. Even when materials are presented in a random order, people recall items in clusters (Buschke has a useful technique for observing this). Most theories assume that the clusters are noun systems. Bourne, et al (1979, ch. 4) review three major memory theories--the feature comparison, network and set models--and show each to be structured around subjects, with predicates somehow linked to the nouns. Another major theory, Human Associative Memory, also uses a subject-predicate system for data storage (Anderson & Bower, 1973).

Collins and Quillian (1969) argue for a hierarchical model of LTM organization, where canary, bird and animal would be examples of linked hierarchical levels. These researchers found that RT required to answer true-false questions (a canary is an animal) declined as the number of traversed levels dropped, and interpreted this as clear support for the model. The result, however, was not always replicated. Meyer (1970) indicates that RT to verify or disconfirm a statement is closely related to category size (i.e., number of items within a given class), and that this may explain Collins and Quillian's result. Conrad (1972) argues that the best predictor of RT in this situation is the property's frequency of association with the noun. Freedman and Loftus (1971) also report that RT is best for responses which are most common in English, but that category size does not determine RT results. This study also makes clear that nouns--not adjectives--form the structure of memory. Subjects were required to satisfy two conditions (e.g., animal-Z) by supplying an appropriate word. The researchers found that the memory search began with the noun (e.g., flower) regardless of whether the adjective (e.g., yellow) was given first or second. In a reasonable revision of their theory, Collins and Quillian (1972) absorbed these results by suggesting that the predicates (is a bird) are stored with the nouns (canary), rather than being inferred from a hierarchical infrastructure.

This explains why RT to confirm that a dog is a mammal would be relatively long: though deducible from an appropriate hierarchy, this predicate is sufficiently rare that its stored association might well be weak or absent. This research ought to be taken quite seriously, because theories of attitude closely resembling the original hierarchical structure in Collins and Quillian (1969) have begun to exert influence in persuasion research (McGuire, 1968; Hunter, Levine & Sayers, 1976; Gold & Russ, 1977; Poole & Hunter, 1979).

The similarity between LTM and the enthymeme rests on a third point, in addition to consistency and categories: that LTM stores the warrants which make inferences from premises. Rumelhart, Lindsay and Norman (1972) argue that LTM includes both a data base and processes which act on the stored information; the processes are actually retained as part of the data. In all the research on desirability or wishful thinking (e.g., McGuire, 1960; 1968), evaluative factors tend to be viewed as logical pollution. But as Wyer (1975) maintains, evaluation ("is good") is just another cognition, identical in principle to any other ("is Italian"). In an extremely important paper, Abelson (1968) shows that all the relations and implications of psycho-logic are explicable (in a purely logical fashion, though Abelson does not go quite this far) by finding appropriate cognitive premises. He provides several examples: "Good actors have good intentions," "bad actors can exercise duplicity," and others (p. 135). If these warrants are stored in LTM, as would seem to be the case, entirely logical cognitive processes could lead a subject to an apparently irrational level of belief in a conclusion. Pleasant things are more easily recalled than negative ones (De Soto & Kuethe, 1959; Packman & Battig, 1978): this suggests that most of us believe "good things are more likely," or some such thought. While people's thinking may be wishful, it is not necessarily irrational, given the premises which may be imported into an argument. But we are getting ahead of ourselves, and must table this line of argument for a moment.

Before leaving the topic of memory, consider retrieval errors for semantic material. The type of stored material, of course, influences the likelihood of error. DeVito (1976) required subjects to give yes or no answers to questions based on pictures being displayed in front of them. He found that the type of question affected error rate: subjects were more likely to give a wrong answer when the question was passive, included a negative, was loaded or used a tag ("isn't it?"). Though this was not a study of LTM, it is of interest here because of DeVito's explanation for these results; in each case, errors increased whenever the question's surface structure departed in some way from its deep structure. Clark (1969) also uses a deep structure explanation for his similar findings regarding two and three term series problems. These results seen related to points we have already made regarding the congruence to stimuli to schemata in LTM.

More directly pertinent are studies by Scribner (1975) and Paris and Carter (1973). Scribner gave premises to West African villagers and asked them to recite or paraphrase the premises to her. She reports that 37% of the villagers could not repeat the meaning of either premise acceptably, after hearing the syllogism three times. Only 18% were accurate on both premises and the conclusion. Recall accuracy was associated with accuracy of solution for the groups in her study. (Even for a sample of American university students, 37% failed to recall the whole problem accurately.) Paris and Carter gave American second and fifth graders lists of related sentences (which permitted inferences), and asked the children to certify

sentences as having been on the list or not. They obtained very high rates of error in identification for true inferences which had not been originally presented (60-65%). "This result does not appear to be accidental or due to generally poor memory for the original sentences" (p. 111). In fact, children were most likely to err on true inferences when the two premises were accurately recalled.

These last few studies underscore the possibility that what appears to be a reasoning error may in fact be a memory error. We are now prepared to evaluate logic as a model of reasoning.

Reasoning

If this paper has a single theme, it is that an argument exists in the receiver's mind, and not in an experimental or rhetorical document. A phenomenological view is required to take account of the emendations to text made by perception and memory, to say nothing of elaborative rehearsal. "The nominal text as a necessary or sufficient data base for higher level outcomes is just too simple a notion. The effective data base and manipulations of that base appear to be outgrowths of each other" (Frase, 1978, p. 193).

The pertinence of Frase's observation may be appreciated by considering the effect of special instructions on logical performance. Cronen and Mihevc (1972) discovered that if they cued subjects to use "logical" standards, logical performance on message evaluations improved markedly. Griggs (1978), too, has found that careful instructions about how to comprehend sentences improved subjects' externally observable meaning. Cronen and Mihevc conclude, "Argument, including the logical form of argument, exists in the mind of the listener" (p. 131). The model they present takes account of both STM and LTM, and their analysis is much in the tradition of Henle (1962), who emphasized the need to consider how premises are understood in order to describe human reasoning (also see Henle, 1978; Ceraso & Provitera, 1971).

The issue of premise comprehension is obviously a critical one. Scribner's (1975) important study also included a Liberian sample. Although these subjects were usually able to recall individual premises accurately, they could rarely recall an entire syllogism properly (about 20-35% accuracy). Because recall was so fragmentary throughout Scribner's samples, she often found that no implicative structure remained to the "syllogism." This problem is so marked in her data that it ". . . makes it impossible to draw any inferences about the logicality of villagers' reasoning processes from data obtained in these studies" (p. 169). Braine (1978), too, is insistant that problems of comprehension be clearly separated from issues of logicality. Other studies reinforce the conclusion that comprehension problems may short-circuit the inferential patterns imposed by experimenters (Chapman & Chapman, 1959; Henle, 1962; Ceraso & Provitera, 1971; Neimark & Chapman, 1975). As a result, we must be aware that ". . . predictions from a logical model to behavior will always require processing assumptions in addition to the logic" (Braine, 1978, p. 4; see Pitz, 1975, p. 134).

Research consistent with this position has considered the possibility of classifying people by the type of processing they seem to use most often. Erickson (1978) asked subjects to draw Venn diagrams to represent "All A are B." About 60% put A inside B, and 40% made A identical to B

(both are possible interpretations, of course, though different inferences would follow). People were very consistent in their interpretations across problems. Dominowski (1976) suggests that people can be classified as logical (12%), atmosphere using (7%), partly logical (i.e., deal only with some of the possible meanings of a premise, but then process it properly--67%) or other (14%). Wright, Phillips, Whalley, Choo, Kee-Ong, Tan and Wisudha (1978) found British students to be much more adept at handling probabilistic language than Asian students. Scribner (1975) ended her study unsure whether or not her villagers could understand hypothetical problems, and Luria (1976) had a similar problem testing Central Asian peasants on non-concrete tasks. Von Domarus (1944) maintained that a particular type of logical error was typical of schizophrenia (but for disconfirming evidence, see Gottesman & Chapman, 1960).

Another line of cognitive research on logic suggests that particular types of may be error-prone for most people. We know that particular premises ("Some A are B") are often involved in errors (Wason & Johnson-Laird, 1972). Scribner (1975) found that recall for syllogisms with universal premises ("All A are B") was superior to that for particular syllogisms for both Americans and villagers. However, some RT research (Meyer, 1970; Ebbeson & Allen, 1979) suggests that "some" may be easier to process than "all" in certain tasks; this issue needs to be clarified. We have already noticed (DeVito, 1976; Wason & Johnson-Laird, 1972) that negatives seem to pose problems; Wyer (1975; 1976) also finds the negative to be a key factor in predicting people's (valid or invalid) conclusion preferences.

Adopting a cognitive rather than documentary view of logic allows us to explain many apparent reasoning errors without having to give up logic as the basic model of argument. We have already reviewed quite a bit of evidence showing that data can be distorted to fit expectation or schemata. Wyer (1975) notices that subjects will make a logically unacceptable premise conversion in order to draw a conclusion from a problem which validly has none. Geis and Zwicky (1971) suggest that some invalid premise conversions may be "invited inferences." For example, many people seem to interpret "if p, then q" as a biconditional--that is, as implying "if not p, then not q." Though the latter is invalid, it will often be true, and so will fit into the relevant schemata. Post hoc fallacies, too, seem often to have pragmatic justifications. Similar observations have been made by Chapman and Chapman (1959) and Henle (1962).

The need to simplify problems may be another reason for apparent errors (Tversky & Kahneman, 1974). Dawes (1964; 1966) read subjects stories, and then asked them questions. He divided their errors into over-generalizations (translating all as some). Noticing that over-generalization simplifies a situation (by allowing a subject to ignore that set of A which is not B, in "some A are B"), while pseudo-discrimination makes the environment more complex, he predicted that the former type of error would be far more frequent--as in fact it was. Dawes seems therefore to have identified a consistent imperative in information processing--simplify--but not a logical difficulty. The need to simplify, of course, was noted earlier in this paper when we observed that our capabilities for information-processing are limited.

Many apparently irrational decisions seem to weight certain evidence improperly. Edwards (1968) found that subjects gave too little weight to new information in revising probability estimates, as did Branthwaite

(1975). Wyer (1975) also compares people with Bayes' Theorem and finds his subjects to be overly conservative. Tversky and Kahneman (1974) discovered that people tend to neglect baseline data (the proportion of the sample in engineering) when judging the occupation of a particular individual whose personality is described. Carroll and Payne (1976) report that people prefer redundant rather than novel information when trying to make judgments. And several studies (Fischhoff, 1975; 1977; Slovic & Fischhoff, 1977; Wood, 1978) indicate that people are unable to discount certain useful information when the task requires it. All these findings amount to the same thing--that people give more or less weight to certain kinds of information than mathematical models would.

But this need not mean that people are irrational. Abelson (1976) is already on record with one plausible explanation of why concrete information is weighted more heavily than abstract: he says people use episodic scripts rather than hypothetical ones. The problem underscored by Abelson's suggestion is that we do not always know what processing model has been selected for use by the reasoner: some models will naturally require certain types of evidence, and find other data irrelevant. Less literature people, as we have noted (Scribner, 1975; Lauria, 1976) apparently do not process abstract information at all. We can hardly describe processing as logical or illogical without first knowing what information is being manipulated. In the last section, for example, we found that wishful thinking may be rational, given certain plausible premises which we would expect to find in an optimistic schema.

This brings back into focus the importance of perceptual and memorial inferences. Making use of scripts, warrants, conditional probabilities, and so forth, stimuli automatically produce inferences which are indistinguishable from the stimuli once the data move into LTM. In searching for the answer to a problem, a person will search through the appropriate LTM scores, testing various solutions against criteria for a satisfactory solution (Greene, 1976; see Miller, Galanter & Pribaum, 1960). The search will not be exhaustive: it will continue only until an acceptable answer is retrieved. Who can say whether the premises which first prove satisfactory will have been part of the stimulus, or perceptual inferences or semantic inferences, or pragmatic ones? When someone is judged illocial in such cases, the assumption is that the LTM search first encountered a stimulus premise; that assumption is plainly unjustified. Empirical research indicates that we cannot restrict ourselves to retrieval of stimulus information in real world problems, even when we strive to do so. As Bartlett (1932) observed, ". . . remembering appears to be far more decisively an affair of construction rather than one of mere reproduction" (p. 205).

Conclusions

A cognitive, phenomenological viewpoint is essential in appreciating the relationship between argument and logic. I understand rhetoric to be concerned dominantly with human rather than textual information processing. The discovery that people provide invalid textual conclusions to textual premises is therefore inconclusive in settling the question of whether argument is logical or not. Attitude theorists have confronted a similar problem, and have discovered that people's behavior is far better predicted

when subjects' own private reactions are considered in addition to those beliefs expressed in a message (Greenwald, 1968; Greenwald & Albert, 1968; Jaccard & Fishbein, 1975; Burnstein & Vinokur, 1975; Petty & Cacioppo, 1977; Love & Greenwald, 1978). Before we can assess the process, we must know what is processed. Attention only to the input and output for a given argument will not illuminate any of the problems reviewed here.

This paper, however, has considered quite a bit of evidence which leads to the expectation that reasoning is logical. The perceptual and memorial inferences are all plausibly logical. Certainly "warm people are cheerful" seems to be the most efficient way to account for someone concluding that a target person is cheerful when told only that she is warm. Semantic processing provides the most useful memory, and semantic memory is organized into categorical schemata that facilitate syllogistic inference. The schemata which play key roles in filtering and elaborating our views of the environment are perhaps best thought of as inference systems composed of warrants (if p, then q) which are applied nearly instantaneously. The likelihood of identifying scripts which control much of our thought (e.g., "enemies of my friends are my enemies") is high. My own judgment is that when enough evidence is available to settle the issue, argument will turn out to be completely logical.

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